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PHOENIX RESOURCE AREA
REMOTE SENSING PROJECT

Final Report

by

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Bureau of Land Management
Division of Scientific Systems
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Denver Federal Center
Denver, Colorado

September 1982

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INTRODUCTION

The Phoenix Resource Area (PRA) project was developed as a result of the BLM-NASA Cooperative ASVT work in the Arizona Strip District. Output products from this project in map and tabular form were the type desired by the Arizona State Office for the PRA project.

The Phoenix Resource Area encompasses 6.3 million acres, of which 920,000 are public. It contains five planning units (PUs): Navaho-Apache, Black Canyon, Middle Gila, Silver Bell, and Central Arizona. Originally, the project was to incorporate the Apache-Navaho PU, Black Canyon PU, and all areas south of Black Canyon PU in three phases. However, due to budget cuts and changing priorities, only the Black Canyon PU phase was initiated. This project was terminated midway by the PRA due to staffing shortages, budget cuts, and a change in Bureau directives.

This report will document the remote sensing classification techniques and related activities applied on the Black Canyon PU project. The report will not attempt a detailed description of project methodology as the author was not involved with the project until close to its termination.

OBJECTIVE

The main objective of the project, as originally envisioned, was to produce usable products for the overall PRA planning process and aid in the completion of SVIM.

STUDY AREA

The Black Canyon PU is located in central Arizona near the northern edge of the PRA (Fig. 1), in the Basin and Range Physiographic Province with the northern two-thirds in the Mountain Region and the southern one-third in the Desert Region. Major vegetation types are chaparral, paloverde/saguaro/shrub, grassland, and creosotebush/shrub. There are small, localized riparian and agricultural areas. The PU contains approximately 600,000 acres, of which 264,000 are managed by BLM.

ANALYSIS METHODS AND PROCEDURES

Preprocessing

A July 10, 1979 (Fig. 2) EROS Digital Image Processing System (EDIPS) scene was selected for the analysis. A June 1979 scene was determined to be optimum for resource enhancement, but was rejected because of poor data quality.

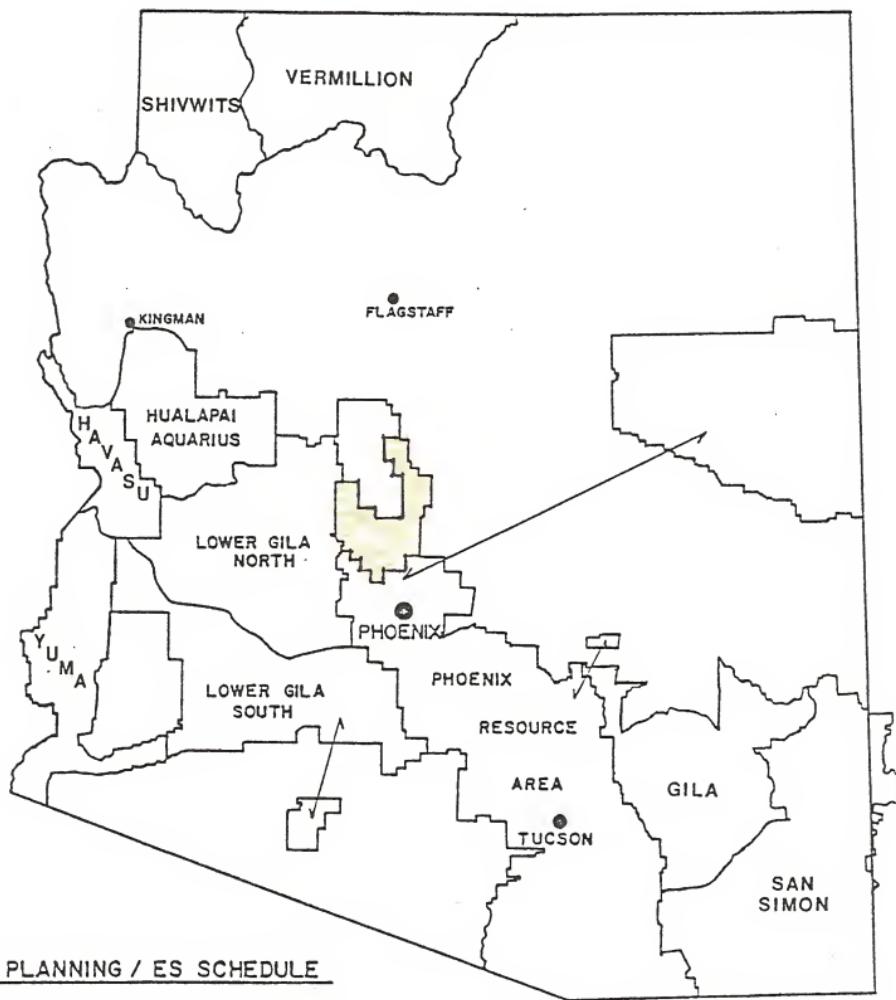


Figure 1. Location of the Black Canyon Planning Unit.

BLACK CANYON PLANNING UNIT, JULY 1979 EDIPS SCENE



Figure 2. Landsat Image (July 10, 1979) Showing the Black Canyon Planning Unit of the Phoenix Resource Area.

Several bad data lines and points were corrected, using standard image processing procedures. A destriping algorithm was applied, but it was decided that there was no visible difference between the before and after images. Therefore, all subsequent processing was done on the non-destriped image.

Approximately 100 ground control points were selected with an even distribution throughout the image (3-4 points per 7.5-minute topographic map). The points were digitized and used to develop a second order transformation.

The image was rotated and registered to a 50-meter UTM grid. All subsequent registration of ancillary data was applied to the same UTM grid. The project area boundary was applied prior to digital classification.

Preliminary Classifications

First Preliminary Classification

Due to the inherent diversity of the Black Canyon PU, it was decided to stratify on the basis of elevation. Using Defense Mapping Agency (DMA) digital data, the project area was stratified into three zones: (1) less than 2,300 feet; (2) 2,300 to 3,000 feet; and (3) greater than 3,000 feet. A grass plateau area was digitized and defined as the fourth stratum.

An unsupervised method of classification was used for each stratum. This process involved: (1) a systematic sampling method to generate cluster statistics for each of the stratum; (2) clustering of data into groups of points having similar spectral characteristics; (3) deleting, retaining, or combining cluster groups based upon statistical separability; and (4) using the statistics from the remaining classes in a maximum likelihood classifier (Hall and Di Paolo, 1982). Each resulting classified image was then grouped into a lesser number of resource classes by the Black Canyon PU personnel. The four stratified images were combined--after class grouping--into one image with 12 resource cover types identified.

Second Preliminary Classification

After taking output from the above classification to the field, it was decided to restratify using different elevation breaks. The first elevation breaks were found to be too broad and not representative of the elevation ranges to which vegetation communities adhered. The vegetation communities identified and their elevational breaks were: (1) creosotebush - less than 1,400 feet; (2) saguaro - 1,400 to 3,000 feet; (3) chaparral - greater than 3,000 feet; and (4) grassland - the plateau area previously identified.

The images were classified and spectral classes grouped as described previously. There were 12 classes identified: water-shadow, agriculture, rock outcrop, closed chaparral, open chaparral, mixed shrub, paloverde/saguaro, creosotebush, disturbed/bare soil, mesquite, cottonwood, and grassland. Figure 3 shows the classification map with allotment boundaries applied.

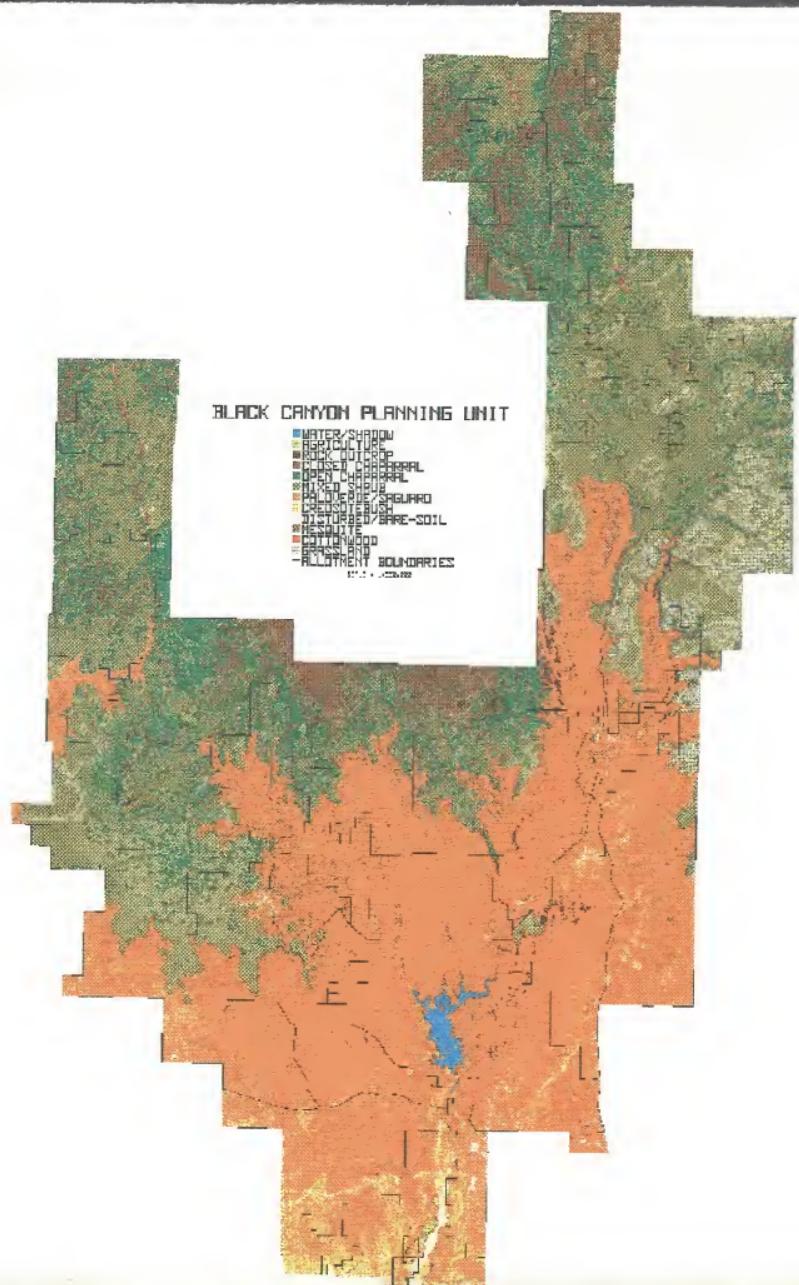


FIGURE 3. PRELIMINARY (FINAL) CLASSIFICATION WITH ALLOTMENT BOUNDARIES APPLIED

Ancillary Data

Several types of ancillary data were merged with the Landsat data set. Among these were: (1) topographic: elevation, slope, and aspect; (2) administrative; and (3) ownership. The elevation data was used in the stratification process. The administrative boundaries (allotments and pastures) were used in the production of tabular data showing cover type by allotment. Allotment boundaries were also overlain on the classified product.

Sample Allocation and Aerial Photography

Primary sample units (PSU) were allocated to each of the 12 resource classes as part of the multistage sampling scheme employed in this project. All PSUs were 150 meters wide by 250 meters long. Three classes (water/ shadow, agriculture, and rock outcrop) were allocated five PSUs each. All other classes were allocated 15 each. A decision was made to take a small sample of the three mentioned classes, as their land area represented only a small portion of the entire PU.

Large scale (1:3,000) natural color photography was flown over each PSU and then photo-interpreted for species composition and density. It was originally planned to use color transparency film; however, due to problems with the BLM contracting office and film supplier time frames, color negative film was used. The resulting contact prints were of slightly lower quality and more awkward to photo-interpret using conventional stereo viewing equipment, although the cost of the prints were half as much as the transparency film.

The photo-interpreter visited a selected number of the PSUs in preparation for the photo-interpretation task. Field notes and ground photos taken at that time were used as an aid in the photo-interpretation effort.

There was no systematic ground sampling of the PSUs. The PRA cancelled the project just as the field-work phase of the project was to begin. In past projects, the ground phase has been used as an aid for final classification through the generation of contingency tables and as an input to final product generation.

Output Products

Symbol maps, with a specific symbol for each class, were produced on the Versatec electrostatic plotter for both preliminary classifications. Both map sets were shot on clear film by the BLM Photo Lab. All symbol maps were produced at 1:24,000 scale to overlay 7.5 minute topographic quadrangles. The set of map overlays from the second classification also showed allotment and pasture boundaries.

Color products of the whole planning unit were produced at scales of 1:250,000 and 1:126,720. These were generated for office use only, as the black and white symbol maps are the superior field product.

Final Classification

The project was cancelled before a final classification (based on the field work and photo-interpretation results) could be developed. However, the Black Canyon PU personnel appeared to be satisfied with the preliminary vegetation classification maps.

DISCUSSION AND CONCLUSIONS

A spectral classification, based upon elevation and landform strata, was developed for the Black Canyon PU. Twelve cover types were identified by the planning unit and resource area personnel. These classes were depicted at 1:24,000 scale on clear film overlays. Aerial photography was flown over selected points and photo-interpreted for species composition and density. The project was cancelled by the Phoenix Resource Area before a final classification could be developed.

The output products, as delivered, appeared to provide useful general vegetation maps. However, since no systematic ground checking was done and contingency tables were never developed, it is difficult to judge the accuracy of the data. It is hoped that the elevational stratification procedures led to a more accurate product.

The cancellation of future projects due to budget cuts and/or changing Bureau priorities can occur at any point in a project. Therefore, it is recommended that future preliminary classifications be treated as final in those instances where funding is minimal or priorities are rapidly changing. As a routine procedure, all classifications developed should be considered as a best and final attempt. Serious thought should be given beforehand to stratification procedures by both DSC and field office personnel in order to enhance the accuracy of the output products.

REFERENCE

Hall, L.B., and W.D. Di Paolo, 1982, "Soil Vegetation Inventories in Arizona," In: Proc. of the 48th Annual Meeting - ACSM-ASP, Tom O'Brien et al. (eds.), Am. Soc. of Photogrammetry.

APPENDIX

PROJECT PLAN
for

PHOENIX RESOURCE AREA

March, 1981

U.S. Bureau of Land Management
Branch of Remote Sensing (D-234)
Building 50, Denver Federal Center
Denver, Colorado 80225

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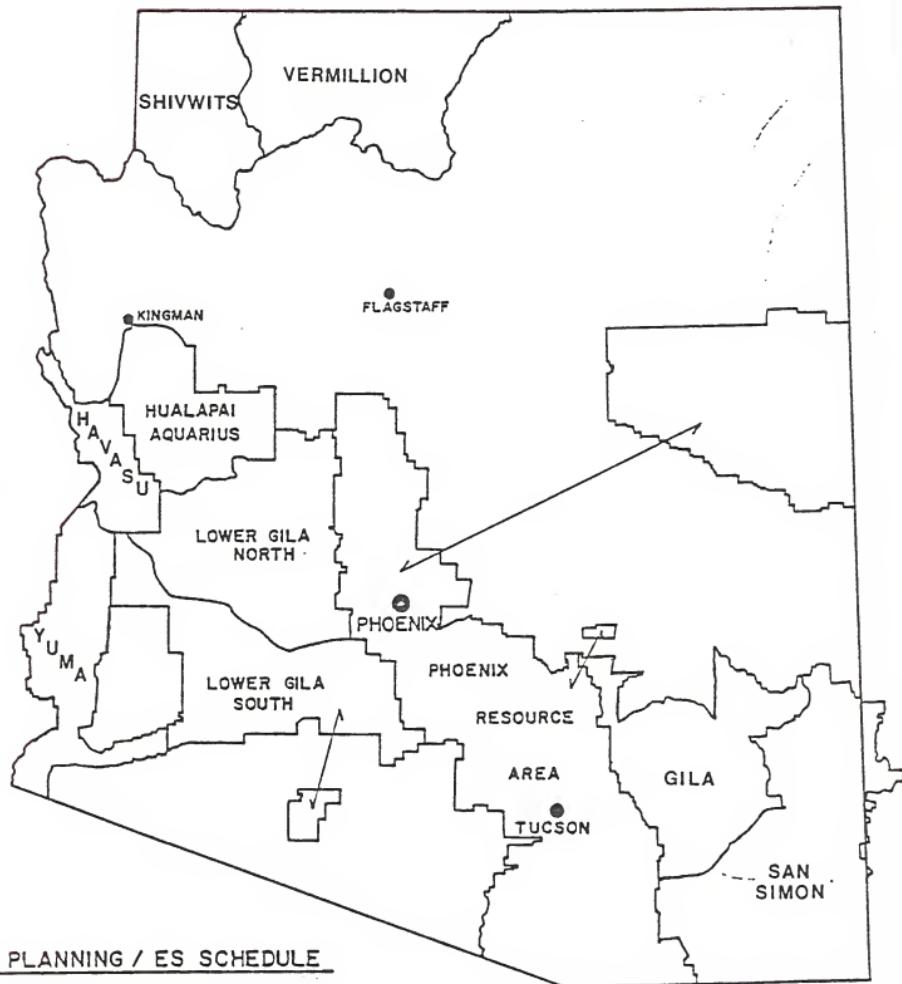
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PHOENIX RESOURCE AREA PROJECT PLAN

1.0 INTRODUCTION AND BACKGROUND

This document represents the Project Plan for the Phoenix Resource Area (PRA) Project in the Phoenix District. The Bureau of Land Management has been involved in remote sensing programs since 1976. In 1979 the Branch of Remote Sensing (BRS) was established in an effort to consolidate the Bureau's remote sensing program under one direction. The PRA project originated due to the effort and results of the BLM-NASA Cooperative ASVT work in the Arizona Strip District and the Idaho soils work within the Boise District ASVT test area. Products from these projects were the type desired by the Arizona State Office for the PRA project. The remote sensing project priorities for the State of Arizona were disclosed by the State Director in his letter of July 1, 1980. The Phoenix Resource Area is listed as second in priority behind the Lake Havasu City Resource Area Project, which is currently being conducted by the Branch of Remote Sensing.

The Phoenix Resource Area encompasses a total of 6,300,000 acres, 920,000 of which are public lands. A map showing PRA is attached to this document (Figure 1). The resource area contains portions of eight counties. Five planning units, Navaho-Apache, Black Canyon, Middle Gila, Silver Bell, and Central Arizona, are within PRA. This project plan will describe the project objectives, technical approach, output products, activity schedule, and milestones. BLM personnel from the Branch of Remote Sensing and support contract personnel from Technicolor Graphics Services will participate in this project using the Bureau's image analysis and processing equipment at the Denver Service Center.



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SEPTEMBER 1979

PLANNING/ES AREAS	PUBLIC LAND ACRES (000's)	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88
HUALAPAI AQUARIUS	943										
LOWER GILA NORTH	1707										
LOWER GILA SOUTH	2097										
PHOENIX RESOURCE AREA	920										
HAVASU											
GILA											
YUMA											
SAN SIMON											

2.0 OBJECTIVES

The main objective of this project is to produce useable products which will aid in the completion of SVIM and the overall planning processes for PRA. This can be itemized as follows:

I. Pre-inventory Stratification -

- A. Spectral maps indicating soil characteristics and delineations.
 - 1. To facilitate third order field mapping.
- B. Refinement of the previous spectral classes to help identify vegetation communities and types to level 3.
 - 1. To assist in the delineation of preliminary range site information.
- C. Where acceptable soils mapping has been completed, it will be digitally entered into the data base and merged with spectral data representing vegetation types.

II. Aggregation and allocation of sample sites.

- A. To aid field personnel in production estimation.

III. Planning System.

- A. URA and RMP overalys and data will be supplied for certain resources.
 - 1. From this spectral and merged ancillary data, planning documents will be produced and can be updated.

The purpose of utilizing this technology is as a tool to decrease the time and personnel needed in the currently scheduled range inventories, and to aid in the accuracy of these inventories. Another purpose is to facilitate the revision of planning documents from spectral and digital anacillary data.

3.0 TECHNICAL APPROACH

3.1 Physical Characteristics of the Phoenix Resource Area.

The Phoenix Resource Area contains portions of the Desert and Mountain Regions within the Basin and Range Physiographic Province, and the Plateau Physiographic Province. The Silver Bell, Middle Gila, and Central Arizona Planning Units are generally located within the Desert Region. Most of the Black Canyon planning unit is situated within the Mountain Region, and the Navaho-Apache planning unit is in the Plateau Province. Navaho-Apache P.U. is separated from the rest of PRA by National Forest Lands. This planning unit is on a plateau at a general elevation of approximately 6000 feet. Vegetative and geologic cover types are diverse within PRA, but the resource area may generally be stratified into the desert, mountain, and plateau regions.

3.2 Specific Tasks

The specific tasks of this project are based upon the needs of the Phoenix Resource Area as stated by them in the coordination meetings at the Phoenix District Office. The following types of data are desired by PRA:

1. Ownership
2. Allotment
3. Geology
4. Soils
5. Terrain
6. Precipitation and temperature
7. Range improvements
8. Cultural features
 - a. 7. and 8. would only be available if District maps with this data are accurate and/or available.
9. SWA boundaries
10. SVIM intersect data

11. Range condition class

a. Specifics on 9, 10, and 11 will be discussed in a coordination meeting in August, 1981.

The final output products desired would consist of maps and/or overlays for the URA/RMP at a scale of 1:100,000 showing vegetation types, sampling design, range sites, wildlife sites, and grazing suitability. Tabular data on an allotment and ownership basis would be needed. Preliminary field sheets would be desired at a scale of 1:24,000 on a 7 1/2' quadrangle basis.

A milestone schedule indicating the time frame for the specific tasks is attached to this document. A generalized procedural outline for the Phoenix Resource Area Project is given below. Specifics for the major headings are described after this outline.

I. Project Planning

A. Meetings and discussions with State Office, District, and Resource Area personnel.

1. Discuss current field effort and information needs.
2. State project objectives, time frames, and end products.
3. Delineate study site.
4. Obtain resource information.
5. Preliminary field reconnaissance.

II. Acquisition of ancillary information and Landsat imagery.

A. Ancillary data.

1. Land status.
2. Pastures and allotments.
3. Resource aerial photography.
4. Topographic maps and orthophoto quadrangles.
5. Geology and soils reports.

6. Climatologic data.
7. Other resource information (i.e. URA, vegetation, etc.)
8. NCIC digital terrain data (DMA tapes).

B. Landsat Data.

1. Obtain computer search of available Landsat imagery.
2. Select favorable scene dates based upon:
 - a. Percent cloud cover.
 - b. Channel quality.
 - c. Time period most favorable to resource enhancement.
 - d. Climatological data.
 - e. EDIPS availability.
3. Order black and white images of selected spectral bands, and small scale color composite imagery for each date.
4. Select final scene or scenes (if using multitemporal data), and order CCT's and corresponding large scale images.

III. Define Project Methodology.

- A. Analyze resource area in separate phases.
- B. Develop vegetation framework.
- C. Decide upon stratification criteria.
- D. Decide upon merged ancillary data.

IV. Landsat Data Processing.

- A. Unpack CCT and DMA tapes.
- B. Examine data and fix any bad lines.
 - 1. Change areas of bad or altered data such as burned areas.
 - a. Register two scenes.
 - b. Make a subscene.
 - c. Develop a transformation.
 - d. Copy and insert.
- C. Create a terrain image.
- D. Register Landsat data to a map base.
 - 1. Select ground control points.
 - 2. Digitize control points.
- E. Digitize test site boundary.
- F. Digitize land status.
- G. Digitize geology.
- H. Digitize allotments and pastures.
- I. Digitize soils (if available).
- J. Digitize environmental stratum (i.e. temperature, precipitation, land form, etc.)
- K. Apply test site mask to Landsat data.
- L. Apply strata mask (if necessary).

- M. Develop training statistics.
 - 1. Within environmental stratum.
 - a. Reduce sample size.
 - b. Cluster.
 - c. Merge or delete statistics.
- N. Classify.
- O. Check classification (using Chi²).
- P. Recluster and classify (if needed).
- Q. Combine spectral class symbols.
- 1. Use resource area personnel.
- R. Combine classified stratum into one image.
- S. Allocate photo sample plots.
 - 1. Plot flight lines and PSU's on maps.
- T. Create 1:24,000 scale Versatec intermediate output on a 7 1/2' quadrangle basis.
- V. Award Photo Contract for LSP.
 - A. Acquire LSP.
 - B. Reproduce LSP.
 - C. Archive LSP.
 - D. Plot LSP's on maps.
 - E. P.I. LSP's.
- VI. Ground Data Collection.
 - A. Organize field work.
 - B. Collect field data.

VII. Final Classification.

- A. Code and enter P.I. and ground data into ERIS.
- B. Generate contingency tables.
- C. Develop final classification and class descriptions.

1. Possible use of resource area personnel.

VIII. Produce Final Output Products.

IX. Cost Determination.

- A. Following each phase of the PRA Project.

3.21 Project Planning

Coordination meetings are held before the start of the project to discuss the needs of the resource area, and the feasibility of utilizing remote sensing technology to meet these needs. These meetings are attended by representatives from the Arizona State Office, Phoenix District Office, and Phoenix Resource Area, in addition to BRS and TGS personnel. After it is decided that the resource area desires the use of remote sensing, and after approval and promised cooperation are given by the District and State Offices, the objectives, time frames, and end products are discussed. The exact study site is delineated and any available resource information on this study site is obtained. At this time, a preliminary field reconnaissance may be scheduled.

3.22 Acquisition of Ancillary Information and Landsat Imagery
Ancillary data available for the resource area is:

- A. Land Status - available on 1:24,000 scale topographic sheets, and also 1:100,000 scale planning base.
- B. Pasture and Allotment Boundaries - available on 1:100,000 mylar base.
- C. Resource Aerial Photography - for the Black Canyon Planning Unit aerial photography is available in color at a 1:24,000 scale. This was flown in 1977. Some high-altitude (U-2) aerial photography is available and would have to be purchased through EDC or ARIS. No resource aerial photography exists for the rest of PRA, and NASA high altitude photography will have to be purchased for these areas if available.

- D. Topographic Maps and Orthophoto Quads - topographic sheets are available at a scale of 1:24,000 while some 1:250,000 scale and 1:62,500 scale sheets are still in print. Some orthophoto quad. sheets are available at the District Office, but others may have to be purchased at \$15/sheet from the Arizona Resources Information System (ARIS).
- E. Geology - county maps at a scale of 1:375,000 are available. Local geology maps at a larger scale are available but little benefit would be gained by their use for this project.
- F. Soils - published soils maps are available in various county reports. The scales on these sheets vary. Other unpublished data exists on aerial photography and orthophoto quads in the offices of the SCS and BLM. Due to the lack of control and availability of soils maps in a form suitable for digitizing, it is questionable whether this information will be able to be entered into the data base.
- G. Climatological Data - generalized precipitation and temperature data is available for the state but this scale may be too small to be useful unless detailed lines can be drawn by resource specialists on larger scale maps.
- H. Other Resource Information - some URA and SVIM information is available for PRA. Also information is available from the Major Land Resource Area (MLRA) document.
- I. Digital Terrain Data - DMA tapes are available from NCIC.
- J. Landsat Data - a computer search will be obtained of available Landsat imagery for PRA. Scenes will be selected based upon EDIP's availability, favorable time period for resource enhancement, percent cloud cover, channel quality, and climatological data. Small-scale black and white images of selected spectral bands will be ordered first, followed by small-scale color composite imagery for a few select dates. After inspection of this imagery and consultation with resource area staff specialists, the final scene or scenes (if using a multitemporal approach) will be selected. The computer compatible tapes (cct's) will be ordered from EROS Data Center (EDC) along with the corresponding 1:250,000 scale color composite images.

3.23 Project Methodology

Due to the large aerial extent of the Phoenix Resource Area, this project will be analyzed in separate phases. These phases, or areas, will be based upon the three major physiographic regions which PRA transcends. Therefore this project plan may be viewed as a plan for 3-4 separate phases or projects which will generally be called the Phoenix Resource Area Project. The anticipated phase sites for PRA are: Apache-Navaho Planning Unit, Black Canyon Planning Unit, and all the area south of the Black Canyon Planning Unit. Physiographically, these areas represent the plateau, central mountain, and sonoran desert regions respectively. The southern area, or desert region, may possibly be divided into two areas based upon the location of administrative units.

A vegetation framework would be developed by personnel from PRA with assistance from DSC staff. PRA would also supply DSC staff with environmental criteria and/or maps for resource stratification. The stratum or zones would be used in the classification process. The Resource Area and District Office would also decide upon ancillary data to be entered into the data base, and make as much of this data available to DSC as possible.

Black Canyon Planning Unit would be the first phase, or area, of this project (Figure 2). The sequence of the other areas would be decided by the District Office at a future meeting. Where soils mapping has been completed in these areas, this data would be digitally entered into the data base if possible. The area would then be analyzed on a vegetation-type basis. Ancillary data would then be used with the Landsat classification to produce the desired output products.

If no soils data exists, the area would probably be classified first for basic cover type information to aid in the field delination of the units. This would be followed by regrouping of classes for vegetation type. In either case, land status, geology, and terrain data will be entered into the data base. Concerning imagery, late spring or early summer data would be desireable for the central mountain region, and mid to late summer data might be desireable for the southern desert and high plateau areas.

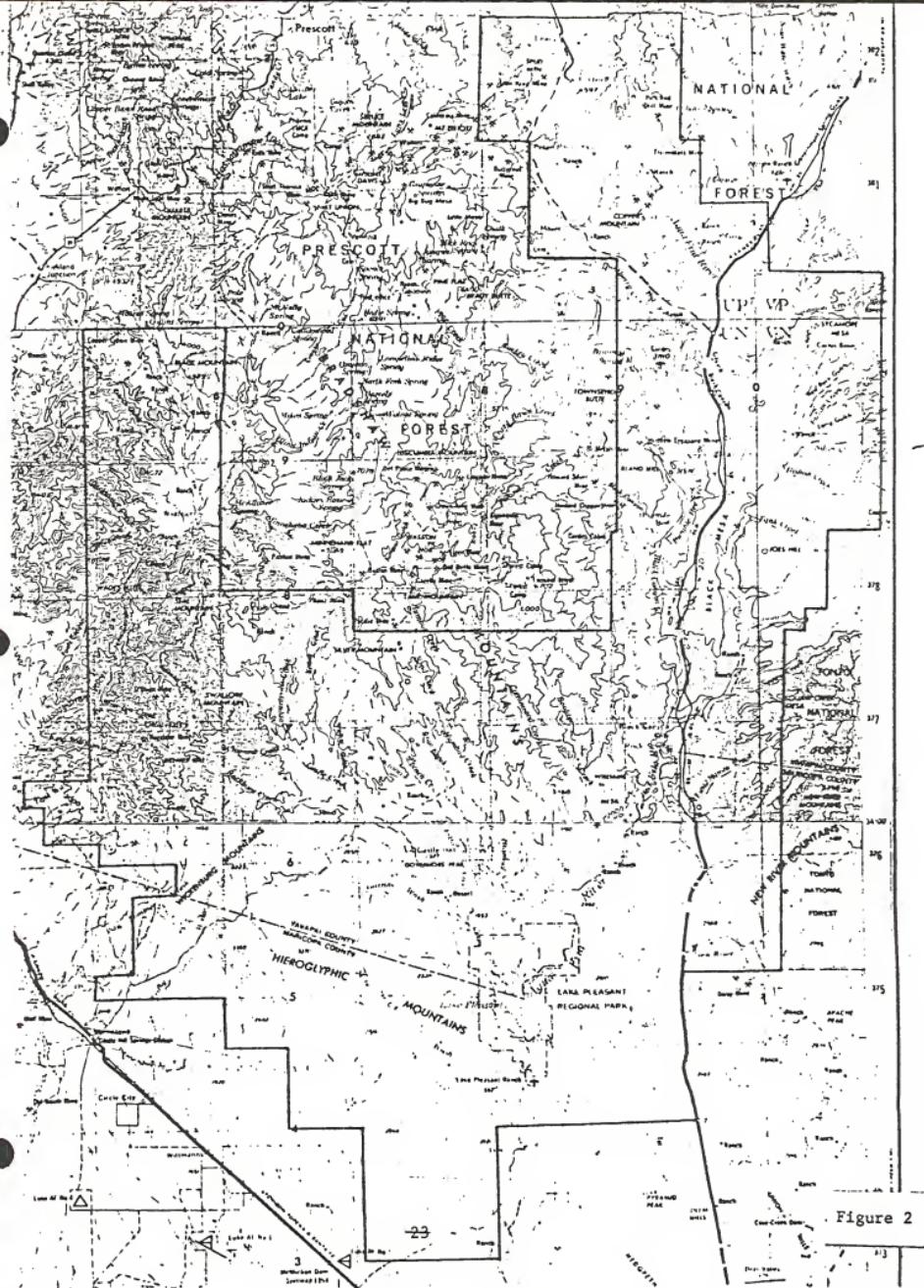


Figure 2

3.24 Landsat Data Processing

The system to be used for the Landsat processing will be the BLM's IDIMS System located at DSC. This system will be operated by BRS and TGS personnel, with support from BLM Phoenix District personnel as required.

3.24.1 The cct's and DMA tapes will be acquired by BRS and unpacked by BRS and TGS.

3.24.2 The data will be examined, and if any bad data lines are found they will be fixed. We will strive to acquire EDIPS imagery for the following reasons:

- A. Lack of stripping.
- B. More recent data.
- C. Convenience and speed of acquiring tapes from EDC rather than GSFC.

If certain areas are found to contain fire scars or other altered data, then two scenes will have to be registered so that good data from one may be inserted into the other.

3.24.3 A terrain image will be created from the DMA tapes by BRS.

3.24.4 The Landsat data will be registered to a map base. Ground control points will be selected by BRS, and these points will be digitized by TGS and BRS. An accuracy of less than one-half pixel is desired.

3.24.5 A geo-block of the test site boundary will be digitized by TGS. This boundary will be obtained by transferring its location onto 1:24,000 scale topographic sheets and then digitizing from these sheets. This geo-block will then be superimposed on the Landsat and terrain data.

3.24.6 Land status will be digitized by TGS and BRS. TGS personnel will travel to Phoenix to manually copy land status available at PRA on 7 1/2' quad. sheets onto another set of 7 1/2' topographic quadrangle maps. This data will then be digitized at DSC. It will only be as accurate as the data from which it is taken.

3.24.7 The geology will be taken from existing county geologic maps and scan digitized by a contractor. The scan digitizing will be arranged by TGS.

3.24.8 Allotment and pasture boundaries will be transferred from existing overlays available at the resource area to 7 1/2' quadrangle sheets by TGS. These sheets will then be digitized at DSC by TGS and overlayed on the Landsat imagery to the accuracy of the base maps.

3.24.9 Soils Data

If output products such as range sites and SWAs are desired, then soils information will be a necessity. This data can either be generated by field crews using Landsat data as a tool to aid in the mapping, or existing data may possibly be digitized. The digitized soils data would then be merged with the Landsat and other ancillary data sets. If soils maps are available, they must meet two basic criteria:

- 1) They must be considered to be of use to the resource personnel. The decision of the quality and utility of existing soils data is made by the District resource specialists.
- 2) Once this utility is established, the maps must be in a form suitable for digitizing. Ideally, this would be soil lines drawn on mylar which is on an orthophotoquad base. It appears that soils information, where it is available in PRA, is in two forms. These are on published sheets in certain county reports which are printed on an air photo base, and on unpublished aerial photography, and a few orthophoto quad sheets. Therefore, for this information to be entered into the data base, UTM or latitude - longitude control points must be plotted on the published sheets, and then, once this control is established, these sheets would be scan digitized. Also, all extraneous lines on these sheets, such as roads and power lines, would have to be eliminated before digitizing. Where soil lines are drawn onto aerial photography, or parts of orthophoto quads, this data would have to be drawn on an orthophoto quad base, transferred to a mylar overlay, then scan digitized. TGS would arrange for all digitization acquisition. Consolidation of soils data would be arranged by District personnel, BRS, and DSC's Division of Resource Inventory Systems (D-460).

3.24.10 Environmental stratum such as land form, precipitation, and temperature regimes will be incorporated if it is decided that this would make the classification more accurate and help in reducing spectral confusion. The District would have the responsibility of supplying this data on a suitable map base, or designating topographic elevations where certain breaks may occur. BRS and TGS would digitize stratum lines drawn on maps. These lines would then be overlayed on the Landsat data, and their location would be as accurate as the maps from which they are digitized. Each stratum may be classified separately and then combined into one map.

3.24.11 The boundaries of each study site will be drawn on 7 1/2' quadrangle sheets, digitized, and applied as a mask to the spectral data. This will be done by TGS.

3.24.12 The strata mask will also be applied to the data, if necessary, as mentioned in 3.24.10.

3.24.13 Spectral signatures will be derived to train the classifier by using an unsupervised technique. A systematic sample will be taken within each stratum, followed by a clustering algorithm to group classes of similar spectral response. The statistics or classes derived from this process may then be statistically merged or deleted. Bispectral plots may be created. This analysis will be performed by BRS personnel.

3.24.14 A maximum likelihood classification algorithm will be used to create a spectral classification map. This will be done by TGS or BRS.

3.24.15 A statistical method will be used to check classification accuracy.

3.24.16 If it is found that inadequate training statistics were developed, the area may be reclustered and classified. Remapping of the classes will be done by BRS.

3.24.17 Spectral classes or class symbols will be combined to reduce the number of classes down to a workable size meeting the needs of the resource specialist. This class combining process will be performed at DSC by District specialists familiar with the area, with the assistance of BRS or TGS personnel.

3.24.18 If the area has been stratified, the stratum will be combined to form one image.

3.24.19 An algorithm will be used to allocate photo sample plots for large scale aerial photography, and as a check on statistical accuracy. Based upon the photo sample plot allocation, flight lines and PSU's will be plotted on topographic maps. Some plotting may have to be done on the Calcomp plotter at EDC.

3.24.20 Intermediate output in the form of 1:24,000 scale 7 1/2' quadrangle sheets will be created for use as field sheets. These sheets will contain the corresponding quadrangle map name along with township and range marks. The output will be developed on the BLM's Versatec plotter using symbols created by BRS. These sheets may also be reproduced at DSC into transparent overlays. A processing function will be employed which divides the study site up into 7 1/2' quadrangle sheets. This work will be performed by TGS and BRS.

3.25 Award Photo Contract for Large Scale Photography (LSP).

After the initial classification, large scale photography will be flown based upon a statistical allocation for each spectral summary class. Approximately 200 flight lines, or less, will be allocated for each phase of PRA. The details of a contract will be worked out by BRS. The LSP will be flown as soon as possible after the preliminary classification. BRS and TGS will also plot the PSU's on the LSP.

3.26 Ground Data Collection

Field work and sampling will be done at the LSP plots by District, BRS, and TGS personnel.

3.27 Final Classification.

P.I. and ground data will be coded and entered into ERIS by TGS and BRS. Based upon photo interpretation and field data, a final grouping of spectral class symbols will be made along with contingency tables and class descriptions. This may possibly require the use of District personnel at DSC.

3.28 Final Output Products.

Final output products will be produced at a scale and type specified by the user. Color coded products will be produced commercially.

3.29 Cost Determination

A detailed record of costs will be made for each phase of the PRA project. This will include materials, travel, computer time and charges, and work months of lab and field crews.

4.0 OUTPUT PRODUCTS

A list of the types of data desired by the District and PRA is given in Section 3.2 under Specific Tasks. Final output will be of the scale and type designated by the user. Based upon the objectives of this project, it will be color coded at a planning scale of 1:100,000. Other use maps or data revisions may be made at a future date upon request from the Phoenix District Office.

5.0 SCHEDULES AND MILESTONES

A milestone schedule for all phases of the PRA project is shown in Table 1. A tentative travel schedule is given in Table 2. The travel schedule is contingent upon certain tasks being completed, budget, and Murphy's Law; thus, some modification in the schedule should be anticipated.

TABLE 1

TASK	FY 80						FY 81						FY 82					
	:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:						:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:							:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:				
PHASE I:																		
I Project Plan																		
II Acquisition of Ancillary Data																		
III Define Project Methodology																		
IV Landsat Data Processing																		
1. Unpack CCT & DMA Tapes																		
2. Examine and Fix bad data																		
3. Create Terrain Image																		
4. Register Data to Map																		
a. Select GCP																		
b. Digitize GCP																		
5. Digitize Test Site Boundary																		

TASK	FY 80												FY 81												FY 82														
	:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:																																						
17. Combine spectral class symbols	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	PRB-BAS-TGS	:	:	:	:	:	:	:	:	:	:		
18. Combine classified stratum	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	:	:	:		
19. Allocate photo sample plots	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	:	:	:		
a. Plot flight lines on map	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BGS-TGS	:	:	:	:	:	:	:	:	:	:		
20. Create 1:24,000 scale output	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	TGS-BAS	:	:	:	:	:	:	:	:	:	:		
V Award Photo Contract for LSP	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	PRB-BAS-TGS	:	:	:	:	:	:	:	BAS-TGS	:	:	:	:	:	:	:	:	:	:	:	
1. Acquire LSP	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	:	:	:		
2. Reproduce LSP	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	:	:	:		
3. Archive LSP	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	BAS	:	:	:	:	:	:	:	:	:	:		
4. Plot PSU's on LSP	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	TGS-BAS	:	:	:	:	:	:	:	TGS-BAS	:	:	:	:	:	:	:	:	:	:		
5. P.I. LSPs	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	BAS-TGS	:	:	:	:	:	:	:	BAS-TGS	:	:	:	:	:	:	:	:	:	:		

TASK	FY 81						FY 82						FY 83					
	:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:																	
VI Ground Data Collection	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
1. Organize fieldwork	:	:	:	:	:	:	BRS-TGS-PDQ	:	:	:	:	:	:	:	:	:	:	:
2. Collect field data	:	:	:	:	:	:	BRS-TGS-PDQ	:	:	:	:	:	:	:	:	:	:	:
VII Final Classification	:	:	:	:	:	:												
1. Coding and: Date Entry:	:	:	:	:	:	:	TGS-BRS	:	:	:	:	:	:	:	:	:	:	:
2. Enter PI & ground data into ERIS	:	:	:	:	:	:	TGS-BRS	:	:	:	:	:	:	:	:	:	:	:
3. Generate contingency tables and develop final classification	:	:	:	:	:	:	BRS	:	:	:	:	:	:	:	:	:	:	:
VIII Produce Final Output Products	:	:	:	:	:	:	BRS-TGS	:	:	:	:	:	:	:	:	:	:	:
IX Cost Determ.	:	:	:	:	:	:	BRS	:	:	:	:	:	:	:	:	:	:	:

TASK	FY 81											FY 82											FY 83													
	:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:											:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:											:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:													
<u>PHASE II (Apache-Navaho)</u>																																				
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III	:	:	+	+	+	+	+	+	+	+	+	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
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V	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
VI	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
VII	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
VIII & IX	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			

TASK	FY 81											FY 82											FY 83												
	:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:											:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:											:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:OCT:NOV:DEC:JAN:FEB:MAR:APR:MAJ:JUN:JUL:AUG:SEP:												
<u>PHASE III (Desert)</u>																																			
I	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
II	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
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IV	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
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VI	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
VII	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
VIII & IX	:	:	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		

TABLE 2

TRAVEL SCHEDULE

Phase I

BRS-TGS

<u>People</u>	<u>DATES</u>	<u>PLACE</u>	<u>PURPOSE</u>
4	July, 1980	Arizona State Office	Coordination
2	December, 1980	Phoenix Resource Area	Project Method
4	February, 1981	Phoenix District Office	Project Method & Coordination
2	March, 1981	Phoenix Resource Area	Land Status and Field Reconnaissance
4	August, 1981	Phoenix District Office	Final Product Determination and Field Reconnaissance
2	November - December, 1981	Phoenix Resource Area	Field Work

Arizona Travel

2	July, 1981	Denver Service Center	Class Groupings
2	August, 1981	Denver Service Center	Class Groupings *
2	February, 1982	Denver Service Center	Final Class Grouping

* Dependent upon quality of first attempt.